

**2024**

**State**

**Planning and**

**Research**

**Program II**

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# Research

## A. Research Program Development, Administration, and Implementation

**Task Lead:** Steve Woelfel

### **Task Purpose:**

To provide oversight and administration of the research program, conduct internal and external outreach activities, and manage associated contracts. The Research Section's work includes conducting research problem statement (RPS) solicitations; organizing RPS evaluation and selection; procuring and administering research contracts; and tracking project performance and implementation efforts and impacts.

### **Accomplishments in prior year:**

- Engaged in scoping and contracting coordination efforts between research project principal investigators (PI) and project champions (PC).
- Procured and/or administered all SPRII-funded research agreements (and/or contracts) with research entities.
- Performed project development and management for all SPRII-funded research projects.
- Conducted three research roundtables to connect MassDOT personnel with researchers during the 2023 problem statement solicitation period.
- Conducted a "Lunch & Learn" session to inform and engage MassDOT and MBTA staff on research activities.
- Received 28 new research problem statements.
- Coordinated the review and prioritization of statements for new FFY24 projects.
- Coordinated initial scope discussion and PI identification approach with agency technical leads for the FFY24 research projects.
- Produced FFY22 Research & Tech Transfer Annual Report.
- Produced four MassDOT Research Quarterly Newsletters.
- Updated MassDOT research website with new contents regularly.
- Conducted web-based project completion survey with project champions, principal investigators and project managers for thirteen projects completed in 2022 to collect feedback and information on how the research process can be improved and research results have been/are to be utilized and implemented.
- Prepared quarterly reports on the status of research and training programs.

**Proposed activities for next year:**

- Continue oversight of research contracts and agreements.
- Continue research project management.
- Prepare quarterly reports on the status of research and training programs.
- Update MassDOT Research Section website regularly.
- Produce FFY23 Research & Tech Transfer Annual Report.
- Produce MassDOT Research Quarterly Newsletters.
- Continue tracking research project performance, implementation and impacts.

**Anticipated products:**

- Executed ISAs and contracts.
- Quarterly reports.
- Regular updating of the Research & Technology Transfer website.
- FFY23 Research & Tech Transfer Annual Report.
- Research Quarterly Newsletters.

**Estimated task completion:** 09-30-2024*Estimated staff salaries and benefits:* **\$116,095.15**

MassDOT staff members	% Time to task
Michael Flanary	20.0
Patrick McMahon	20.0
Nicholas Zavolas	20.0
Anil Gurcan	20.0
Austin Sanders	20.0
Research Manager (TBH)	20.0

**Estimated task budget:** **\$116,095.15**

MassDOT holds a multi-year Interdepartmental Service Agreements (ISA) with the University of Massachusetts Amherst for UMass Transportation Center (UMTC) services in assisting MassDOT with transportation research, training, and technology transfer activities for FFY20-25. There are four components in the ISA Amendment executed in August 2022: Massachusetts Cooperative Research Program (Task B), Local Technical Assistance Program (Task C), MassDOT Technical Services (Task D) and MassDOT Conference Services (Task J).

## B. Massachusetts Cooperative Research Program (MCRP)

**Task Lead:** Steve Woelfel

### **Task Purpose:**

Through the MCRP component, the Research Section directs, coordinates, and oversees UMTC to provide research support and conducting tasks as requested.

MCRP's services fall into five categories:

- a) Literature searches and reviews: Perform literature and information searches and syntheses at the Research Section's request.
- b) Research subtasks: Perform quick-turnaround subtasks to address MassDOT's imminent research needs. These subtasks can typically be completed in under 12 months (including a 3-month final product review and acceptance period) with a cost less than \$100,000, and carried out by researchers with matching expertise (principal investigators) within the UMass system, but not by UMTC staff directly funded under the ISA.
- c) Research project support: Assist MassDOT during the annual problem statement solicitation process; plan and support research roundtables; assist with identification of potential principal investigators (PI) with expertise matching specific research needs; assist with initial scopes of work descriptions; ensure quality control (final copy-editing and 508 compliance of all research final reports and cut sheets); and submit final reports to Transportation Research International Documentation (TRID), National Transportation Library and other national transportation research record repositories.
- d) Research collaboration and outreach support: Maintain the UMTC associated transportation researcher network, curate and host MassDOT transportation research and innovation webinar series, assist MassDOT with the National Cooperative Highway Research Program (NCHRP) problem statement review process, compile contents for MassDOT Research Annual Report, and other activities as needed.
- e) Research project administration: Provide fiscal and procedural administration for all research projects with UMass Amherst, including budget preparation, invoicing backup preparation, template developments/updating, accounting, orientation/training, and on-demand activities. Provide advice to other state universities on how to administer ISAs with MassDOT.

Under Category B, MassDOT intends to conduct up to 3 research subtasks during FFY24 through the UMTC ISA to address research problems and needs. Some of the subtasks are generated from the annual research problem statement solicitation process and some may be selected outside of that

process. The second types of research subtasks will depend on the emerging agency needs and may include technical assistance in implementing completed research. The Research Section works with MassDOT project champions to identify the suitable principal investigators for each of the subtasks based on researcher expertise and anticipated completion dates, and assists with the development of scopes, budgets, and schedules for these projects. MassDOT will coordinate with and request FHWA's approval of scopes and budgets prior to the issuance of any research subtasks.

#### **Accomplishments in prior year:**

- Completed two research subtask (FYA Phase II and Concrete Sidewalks Phase II)
- Initiated and administrated two research subtasks (Speed Management and Emergency Response Synthesis, Using AI Algorithms to Auto Detect Crosswalks.)
- Assisted with 2023 MassDOT Research Problem Statement solicitation (for FFY24 SPR Work Program).
- Assisted with research solicitation outreach materials and hosted the outreach sessions.
- Assisted with research project completion survey.
- Drafted and delivered the 2022 Research and Tech Transfer annual report.
- Conducted literature searches for 28 received problem statements.
- Drafted brief project statements for the final list of FFY23 projects to initiate PI identification process.
- Assisted with PI Interest Statement solicitation.
- Facilitated dialogues between the Affiliate network/academic researchers and MassDOT practitioners.
- Maintained the network of the transportation affiliated researchers.
- Obtained copies of research publications at MassDOT staff's request.

#### **Proposed activities for next year:**

Subtasks:

Research subtasks to be completed during FFY24 include:

B.3. Speed Management and Emergency Response (continued Research Subtask) This is a synthesis of state-of-the-practice and stakeholder engagement for identifying the suitable speed management countermeasures and strategies for potential field experiments. The total amount is \$119,989 and the duration is 12 months, with a start date of April 15, 2023. The draft final report is expected to be submitted in FFY24 Q2.



B.4. Artificial Intelligence Framework for Midblock Crosswalk Detection across Massachusetts (continued research subtask) Non-intersection or midblock crosswalks are critical to safety, as over half of non-intersection pedestrian-involved crashes occur within the roadway as opposed to the sidewalk. The goal of this project is to provide MassDOT with a GIS layer of crosswalks across the state using computer A.I. and 2020 and 2021 satellite images; this deliverable can be immediately harnessed for vulnerable road user safety assessment and planning purposes. The estimated total cost is \$99,998 and the duration is 10 months, with a start date of May 1, 2023. The draft final report is expected to be submitted in FFY24 Q1.

Additional subtasks will be developed based on emerging needs and be issued with FHWA's approval; such subtasks may include technical assistance in implementing completed research.

- Continue to provide research services in the categories listed above.
- Complete the two existing research subtasks listed above.
- Initiate and perform up to 2 new research subtasks under MCRP's Services (Category B above).
- Assist Research Section in preparing FY23 Research & Tech Transfer Annual Report.
- Assist Research Section in preparing FY24 quarterly updates.

**Anticipated products:**

- Delivery of research subtask interim and final reports.
- Delivery of monthly and quarterly reports.
- Delivery of 2023 Research & Tech Transfer Annual Report.
- Delivery of other research services as requested by the MassDOT Research Section.
- Delivery of logistical support for the annual NCHRP problem statement review.

**Estimated task completion:** 09-30-2024

*Estimated staff salaries and benefits:* **\$48,074.00**

MassDOT staff members	% Time to task
Michael Flanary	10.0
Nicholas Zavolas	10.0
Anil Gurcan	10.0
Austin Sanders	10.0
Research Manager (TBH)	10.0

**Estimated task budget:** \$698,074.00

*Estimated consultant costs: \$650,000.00*

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
<b>MCRP / 109600</b>	\$5,381,241.00	\$3,422,241.16	\$650,000.00	\$1,308,999.84	UMass Amherst	10-01-2022	None

*Consultant notes:* This is the MCRP component of the MassDOT-UMA UMTCA ISA Amendment for FFY23-25. The duration of the whole ISA, after being amended, is 72 months.

## C. Local Technical Assistance Program (LTAP)

**Task Lead:** Steve Woelfel

### **Task Purpose:**

Baystate Roads is the longstanding program name for Massachusetts LTAP, and it serves as a conduit for information transfer on technologies, best practices, and methodologies for operating, maintaining, and managing municipal departments of public works and highway departments throughout the Commonwealth. The program also serves as an efficient communications network, by which MassDOT transfers policy information, engineering directives, program funding, and other updates to the 351 municipalities in Massachusetts. Please see Appendix B for FFY24 LTAP Training Plan.

### **Accomplishments in prior year:**

The Local Technical Assistance Program (LTAP) resumed in-person training in 2023 while also providing a variety of remote options including virtual classes, blended learning, webinars and self-paced virtual courses. Major accomplishments to date, with estimated Quarter 4 trainings scheduled, provided over 150 training events attended by about over 2,500 participants in total. Below shows the list of trainings provided:

- All About Liquids
- Complete Street 201 Design your Streets for People
- Backhoe Maintenance Essential
- Basics of a Good Road
- Class 2 and 4G Hoisting
- Chainsaw Maintenance
- Chainsaw Skills & Safety – 2 Day
- Chainsaw Storm Debris Cleanup
- Complete Streets 302: Safety Countermeasures
- Complete Streets 303: Bicycle/Pedestrian Network Planning
- Confined Space Hazard Awareness
- Design of ADA Curb Ramps & Pedestrian Access Routes
- Driving your Asphalt Pavement Maintenance Program
- Essential Supervisory Skills (WFD: Management Focus)
- FAA Remote Pilot Certification Test Preparation
- FHWA NHI-133121V Traffic Signal Design and Operation
- Flagger/First Aid/CPR Certification

- Gravel Roads: When the Dust Settles
- Illicit Discharge Detection & Elimination (IDDE) Training for MS4 Permitting
- Installation of Pre-cast Catch Basins
- Large Mower Operations & Safety
- Load Securement & Rigging
- MAPIT
- Municipal DPW Budgeting and Financing
- OSHA 10hr. Construction Training
- Pavement Markings – Use, Application, Compliance and Materials
- Rigging and Load Securement Virtual Minisode
- Snow & Ice Operations for Front Line Employees
- Snow & Ice Operations for Supervisors
- Spreader Calibration
- Stormwater Regulations, Erosion and Sediment Control
- Street Tree Essentials
- Stump the Instructor: All Things Hoisting
- Stump the Instructor: New year, New Stump & Anything Winter Operations Related
- Stump the Instructor: The Power of GISA in the DPW
- Stump the Instructor: Understanding Asset Management Systems Utilized by Municipalities
- Traffic Signal Warrants How to Perform, Assess, and Satisfy the Requirements of Each
- Trenching and Excavating Safety
- Backhoe Maintenance Essentials
- Using 460 Specs to Help Bid Your Next Paving Contract Welding Equipment Safety & Operation
- Wood Chipper Operations & Safety
- Work Zone Safety
- Work Zone Design for Pedestrian and Bicycle Safety
- Workforce Development: Management Focus (communication, retention, team building)
- Various AASHTO TC3 web-based self-pace classes

LTAP supporting staff also performed below activities:

- Conducted a training feedback survey at end of each class.
- Conducted training impact evaluations on selected classes.
- Hosted one hybrid LTAP Advisory Board meeting.
- Developed job-aids on selected topics for municipal DPWs.
- Provided monthly and quarterly reports.
- Published quarterly LTAP M3 newsletters.

- Updated LTAP website frequently to disseminate information.
- Conducted and evaluated FFY24 LTAP training needs survey.
- Developed draft FFY24 LTAP Training Plan.

**Proposed activities for next year:**

- Continue to prepare, coordinate, and deliver training classes to municipalities per the FFY24 training plan (Appendix B), and yet be flexible to accommodate evolving, critical municipal needs and to follow MassDOT's guidance.
- Continue to expand and deliver online training and information sharing videos.
- Continue to develop and implement suitable approaches to evaluate training effectiveness.
- Continue to provide monthly and quarterly updates.

**Anticipated products:**

- Delivery of at least 100 virtual or in-person training sessions throughout the state.
- Quarterly M3 newsletters.
- Updates to and maintenance of LTAP website.
- Training and conference feedback surveys and summaries.
- Monthly and quarterly reports on LTAP training activities.
- Draft FFY25 LTAP Training Plan.

**Estimated task completion:** 09-30-2024

*Estimated staff salaries and benefits:* **\$12,000.00**

MassDOT staff members	% Time to task
<b>Research Manager (TBH)</b>	10.0
<b>Michael Flanary</b>	5.0

**Estimated task budget:** \$912,000.00

*Estimated consultant costs: \$900,000.00*

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
<b>LTAP / 109600</b>	\$7,420,807.00	\$4,512,846.45	\$900,000.00	\$2,007,960.55	UMass Amherst	10-01-2022	None

*Consultant notes:* This is LTAP component of the four components of the MassDOT- UMTC services ISA Amendment for FFY23-25. The duration of the whole ISA, after being amended, is 72 months.

## D. MassDOT Training Services (MTS)

**Task Lead:** Steve Woelfel

### **Task Purpose:**

MassDOT Training Services (MTS) assist MassDOT in developing and implementing an annual plan to provide essential and high-quality technical training to MassDOT employees with a focus on the Highway Division. Through this component, MassDOT coordinates, directs, and oversees the UMTC training team as it provides training classes requested by MassDOT's Highway Division to its staff throughout the state. Please see Appendix C for FFY24 MTS Training Plan.

### **Accomplishments in prior year:**

MassDOT Training Services resumed in-person training while also offering trainings through several other formats including blended learning approaches; combining self-paced online modules and live streamed sessions; webinars; and on-demand video options.

MTS provided over 100 classes for over 2,000 attendees. Individual classes are listed below:

- ACI Certifications
- Amtrak Contractor Orientation
- Annual Safety Fresher
- Asphalt 101
- AutoCAD Essentials
- AutoCAD Civil 3D Essentials
- AWS WPS & PQR Explained
- Bucket Truck Operations & Safety
- Chainsaw Safety and Storm Damage Awareness Training
- Chainsaw Operation & Safety -2 Day
- Confined Space Refresher
- Construction Supervisor License Renewal Course
- Design of ADA Curb Ramps and Pedestrian Access Routes
- Drainage – Roadway Maintenance and Reconstruction
- Fall Protection – Ladders
- FHWA-NHI-120053 Bridge Inspection Refresher
- FHWA-NHI-130087-Inspection and Maintenance of Ancillary Highway Structures – BSCES
- FHWA NHI 132034 – Ground Modification Methods

- FHWA-NHI-132094B – LRFD Seismic Analysis and Design of Structural Foundations and Earth Retaining Structures
- FHWA-NHI-133121 – Traffic signal Design and Operation
- FHWA-NHI-135027-Urban Drainage Design
- FHWA NHI-135048 - Countermeasure Design for Bridge Scour and Stream Instability
- FHWA-NHI-310110V-Federal-Aid Highways – 101
- FHWA-NHI-380070 - Highway Safety Manual Practitioners Guide Geometric Design
- Highway Construction Survey
- Hoisting initial License Test Prep
- How to Read Construction Drawings
- Keolis Safety Compliancy Training
- Large Mower Operations & Safety
- Load Securement and Rigging
- Mass Costal Safety Compliance
- MassDOT Project Manager Certification Training
- MA Hoisting License Exam Prep 2A, 1C, 4G
- MBTA ROW training
- NETTCP Certifications
- OSHA 10 Construction Training
- Public Speaking and Presentation Skills
- Professional Engineer Refresher Course
- Scaffolder User Training
- Stormwater Regulations, Erosion and Sediment Control
- School of PE – FE Prep Course
- Trenching and Excavation Safety
- Slips, Trips and Falls, Lifting Ergonomics
- Traffic Signal Warrants How to Perform, Assess, and Satisfy the Requirements of Each
- Welding Workshop for Highway Structures
- Virtual Presentation and Meeting Best Practices Training
- Woodchipper Operations & Safety
- Work Zone Safety for Construction Personnel
- Work Zone Safety for Maintenance Field Personnel

MTS support staff also performed the followings:

- Procured, coordinated, and administered 3-party training and certification services to meet Highway Division needs.



- Worked on streamlining MTS processes to improve training effectiveness and quality including needed coordination, registration, evaluation, and customized contents to reflect MassDOT's technical requirements.
- Conducted FFY24-25 training needs survey.
- Coordinated with the Highway Division to develop FFY24 training plan.
- Submitted monthly and quarterly reports.

**Proposed activities for next year:**

- Prepare, coordinate, and deliver MTS training classes per the FFY24 Training Plan (Attachment C), which will be updated quarterly based on availability and schedule of external training classes and to accommodate critical, emerging Highway training needs.
- Coordinate with the Highway Division to accommodate on-demand training needs.
- Record training attendance to inform future plans.
- Conduct training needs and effectiveness surveys.
- Develop FFY25 annual training plan.
- Prepare and submit monthly and quarterly reports.

**Anticipated products:**

- Implementation of the FFY24 Training Plan.
- Accommodation of Highway Division urgent training needs.
- Training attendance records.
- Training feedback surveys and summaries.
- Development of FFY25 MTS annual plan.
- Monthly and quarterly reports.

**Estimated task completion:** 09-30-2024

**Timeline for new consultant support:** MTS

Consultant name: UMass Amherst

Scope development and FHWA review/approval: 08-15-2022

Contract negotiations and FHWA review/approval: 08-31-2022

Total duration of task: 72 months

*Estimated staff salaries and benefits:* **\$12,000.00**

MassDOT staff members	% Time to task
Research Manager (TBH)	10.0
Michael Flanary	5.0

**Estimated task budget: \$1,712,000.00**

*Estimated consultant costs: \$1,700,000.00*

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
<b>MTS / 109600</b>	\$8,106,771.00	\$4,007,988.28	\$1,700,000.00	\$2,398,782.72	UMass Amherst	10-01-2022	09-30-2025

*Consultant notes:* This is the MTS component of the four components of the MassDOT- UMTC Services ISA Amendment for FFY23-25. The duration of the whole ISA, after being amended, is 72 months.

## E. Short-Term Research Projects

**Task Lead:** Michael Flanary

### **Task Purpose:**

To perform the research contained within this task, MassDOT contracts directly with universities, research institutes and/or private companies. The respective anticipated duration of active investigation and report writing efforts for short-term, medium-term and long-term projects are, respectively: less than 15 months, 15-21 months, and longer than 21 months (including 3 months of final report review, approval and 508 compliance process). There may be occasions when a project actual duration doesn't align with the anticipated duration due to challenges arising during research investigation and beyond the project team's control. Under such circumstances, additional time may be granted pending FHWA's approval, and the project shall remain within the original category for fiscal tracking purpose. The Research Section conducts annual research problem statement (RPS) solicitations to collect research needs from agency staff. The submitted problem statements are then prioritized based on MassDOT Division/Shared-Service Office Senior Leaders' rankings, MassDOT overall priorities, and research funding eligibility and availability. The Research Section assists MassDOT project champions with literature searches; the drafting of scopes of work; identification and selection of principal investigators, and the administration of project agreements/contracts, deliverables, final report reviews and publication, and coordination with FHWA.

The purpose of "Task E. Short-Term Research Project" is to perform research projects that are less than 15 months in duration.

Subtasks:

### **1. Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide Phase III (Continuing Project)**

A four-phased approach was planned to complete this research effort. Phase I (Literature Review and State of Practice Assessment) was completed in June 2021 and Phase II (Develop an AASHTOWare Pavement ME User Manual and the Local Experimental Plan and Sampling Template) deliverables are being reviewed. Phase III (Sample and Test Mixtures for Local Calibration and Field Data Collection) will be based on the local experimental plan and sampling template developed under Phase 2, and a larger volume of mixtures will be tested to have the best local calibration possible for Massachusetts.

Additionally, field data needed for calibration will be collected. All this lab and field data will be used in Phase IV (Calibrate and Validate the M-E Prediction Models). Phase III started in FFY23 Q1. Continuing with field sampling and lab testing.

## **2. Methods to Identify Problematic Carriers and Prevent Infrastructure Damage (Continuing Project)**

This project aims to develop methods to connect and harmonize various Massachusetts datasets on carriers, permits, citations, road accidents, road infrastructure inventory, freight restrictions to improve the use and availability of relevant datasets. Following a compilation of state-of-the-practice from other states, the available datasets are examined to determine consistency and usability on mirrored or relational fields. Specific datasets and their fields are being categorized by relevancy to formulate data canisters for analysis across multiple enterprise platforms. Thresholds will be determined to identify overrepresented carriers and resulting trigger points on a rolling basis at which further investigation should be conducted. Additionally, experimentation of a comprehensive scoring system will assign individual factors a weight to best accommodate incomplete data in determining overall carrier risk to road and infrastructure safety. Research results will provide a solid foundation for conducting risk assessments of overweight/oversize use and flagging problematic use of existing weight-permit practices to further protect roadway assets and sensitive bridge structures. NTP was issued in June 2022; literature review and data collection have been completed; structure and content analyzing and correlating of multiple data sources are in process. FHWA approved a 4-month No Cost Time Extension in July 2023, extending the project end date to March 30, 2024.

## **3. Feasibility Study of 3D Printing Applications for Bridge Elements in MA (Continuing Project)**

Building on the promising experimental results of Phase I, i.e., additive repair of real corroded steel plates in the lab, the current project aims at exploring the onsite feasibility of additive repair technology for corroded steel beam ends. Cold spray solutions as well as other applicable onsite technologies will be studied and tested. The project will further connect the interested MassDOT bridge engineers with additive manufacturing facilities to explore potential collaborative opportunities around implementation of candidate objects identified during Phase I. Additionally, the project will further characterize the cost and value of implementing these candidate components by using specific econometric models and will contextualize that cost within MassDOT-specific operational models and planning. NTP was issued in April 2022. Sample preparation and equipment testing are in process. Expecting a no-cost-time-extension in Q1 of FFY24, extending project to August 2024.

## **4. Data-Driven Approach for Transit Capital Planning (Continuing Project)**

This research aims to develop new approaches and identify best practices by peer State-level agencies for MassDOT to compile, aggregate and understand data that enables better decision making. It will also work to define a standard operating procedure, focusing on what data is currently being collected and the existing collection methods used at MassDOT, and how this data is ultimately integrated into or used to validate MassDOT's forecast of need. This research could eventually serve as the framework

for a solution that will help to streamline time-consuming data collection efforts while ensuring the accuracy of the predicted need across MassDOT's grantees. Research investigation is expected to be predominately completed by FFY23 and the draft final report is expected in FFY24 Q1. Expect project to advance to full completion by 12/31/2023.

#### **6. Using Traffic Signals to Limit Speeding Opportunities on Arterial Roads (Continuing Project)**

This project will provide guidance and case studies for developing traffic signal timing plans in Massachusetts that limit the number of speeding opportunities, while addressing other signal control objectives such as capacity and delay. This will be achieved by creating a method for determining the number of speeding opportunities afforded by a signal timing plan on an arterial with the similar inputs used in traffic signal timing design and developing an easy-to-use, no-cost tool that implements this method. This project will include alternative signal timing plans (task 3), a guidebook (task 4), collecting “after” speed and speeding opportunities data and case studies (task 5), and a final report (task 6).

#### **Accomplishments in prior year:**

- Managed "Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide Phase III" project. 30% completed.
- Managed “Methods to Identify Problematic Carriers and Prevent Infrastructure Damage” project. 55% completed.
- Managed “Feasibility Study of 3D Printing Applications for Bridge Elements in MA” project. 50% completed.
- Managed “Data-Driven Approach for Transit Capital Planning” project. 60% completed.
- Completed “BIM for Transit Infrastructure: A Feasibility and gap assessment with current practices and systems at the MBTA” project.
- Managed “Using Traffic Signals to Limit Speeding Opportunities on Arterial Roads” project. 65% completed.
- Completed "Uncovering the Root Causes for Truck Rollover Crashes on Ramps" project.
- Completed "Microfiltration Treatment and Design Options" synthesis project.
- Identified FFY24 short-term research projects.

#### **Proposed activities for next year:**

- Complete "Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide Phase III" project.
- Complete “Methods to Identify Problematic Carriers and Prevent Infrastructure Damage” project.

- Complete “Feasibility Study of 3D Printing Applications for Bridge Elements in MA” project.
- Complete “Data-Driven Approach for Transit Capital Planning” project.
- Complete “Using Traffic Signals to Limit Speeding Opportunities on Arterial Roads” project.
- Identify FFY25 short-term research projects.

**Anticipated products:**

- Interim deliverables and final reports for all short-term research projects.
- List of short-term projects for FFY25.

**Estimated task completion:** 09-30-2024

*Estimated staff salaries and benefits:* **\$52,047.57**

MassDOT staff members	% Time to task
Michael Flanary	10.0
Patrick McMahon	10.0
Nicholas Zavolas	10.0
Anil Gurcan	10.0
Austin Sanders	10.0
Research Manager (TBH)	5.0

**Estimated task budget:** \$577,414.57

Estimated consultant costs: \$525,367.00

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
<b>1. Implementing the AASHTO Mechanistic-Empirical Pavement Design Guide Phase III (Continuing Project) / 120714</b>	\$400,167.00	\$40,000.00	\$360,167.00	\$0.00	UMass Dartmouth	11-22-2022	05-31-2024
<b>2. Methods to Identify Problematic Carriers and Prevent Infrastructure Damage (Continuing Project) / 117649</b>	\$126,200.00	\$65,000.00	\$61,200.00	\$0.00	UMass Amherst	06-02-2022	03-30-2024
<b>3. Feasibility Study of 3D Printing Applications for Bridge Elements in MA (Continuing Project) / 117646</b>	\$150,000.00	\$88,000.00	\$62,000.00	\$0.00	UMass Amherst	04-25-2022	11-30-2023



<b>4. Data-Driven Approach for Transit Capital Planning (Continuing Project) / 119829</b>	\$100,000.00	\$78,000.00	\$22,000.00	\$0.00	UMass Amherst	08-31-2022	12-31-2023
<b>6. Using Traffic Signals to Limit Speeding Opportunities on Arterial Roads (Continuing Project) / 114372</b>	\$140,000.00	\$120,000.00	\$20,000.00	\$0.00	Northeast University	07-01-2021	02-28-2024

## F. Medium-term Research Projects

**Task Lead:** Michael Flanary

### **Task Purpose:**

To perform the research contained within this task, MassDOT contracts directly with universities, research institutes and/or private companies. The respective anticipated duration of active investigation and report writing efforts for short-term, medium-term and long-term projects are, respectively: less than 15 months, 15-21 months, and longer than 21 months (including 3 months of final report review, approval and 508 compliance process). There may be occasions when a project's actual duration doesn't align with the anticipated duration due to challenges arising during research investigation and beyond the project team's control. Under such circumstances, additional time may be granted pending FHWA's approval, and the project shall remain within the original category for fiscal tracking purpose. The Research Section conducts annual research problem statement (RPS) solicitations to collect research needs from agency staff. The submitted problem statements are then prioritized based on MassDOT Division/Shared-Service Office Senior Leaders' rankings, MassDOT overall priorities, and research funding eligibility and availability. The Research Section assists MassDOT project champions with literature searches; the drafting of scopes of work; identification and selection of principal investigators, and the administration of project agreements/contracts, deliverables, final report reviews and publication, and coordination with FHWA.

The purpose of "Task F. Medium-term Research Projects" is to perform research projects that are between 15 and 21 months in duration.

Subtasks:

### **2. Energy-Focused Decision-making Framework for MBTA Operations and Planning (Continuing Project)**

This project aims to develop an enhanced system-wide energy model for MBTA urban rail transit building on prior efforts and harnessing network-specific substation energy data and to calibrate train-specific energy models for all the lines in the MBTA in order to evaluate high-resolution trajectory and ridership impacts on energy consumption. It will eventually build a decision-support tool to provide system-wide energy and cost predictions for given input operational strategies in order to enable robust planning by the MBTA.

### **3. Accessible Bus Stop Design in the Presence of Bike Lanes (Continuing Project)**

The MBTA has been upgrading its bus stops for better accessibility, especially for wheelchair users and visually impaired individuals. While these accessible bus stops are integrated with complete street

designs and other multi-modal accommodations, the impact of other modes and related infrastructure on transit user safety (e.g., conflicts between bicycles traveling on adjacent bike lanes and transit riders), has not been fully investigated. There is a pressing need for a better understanding of the impacts of bicycle infrastructure on bus stop accessibility and the exploration of mitigation plans that will ensure an accessible, equitable, and safe travel experience for all travelers. The objectives of this research are to: 1) investigate interactions of bus riders and bicyclists when bicycle infrastructure is adjacent to bus stops, and 2) propose design improvements to mitigate conflicts between bus riders of all abilities and bicyclists. Characterization of bus rider and bicyclist interactions (task 2) expected to be completed by December, 2023. Design recommendations submitted by April, 2023. Project set to close in August, 2024.

#### **4. Developing a Salt Spreader Control Program based on Grip Sensor (Continuing Project)**

Deicing material conservation makes fiscal sense and is also critical to protecting environmental resources while engaged in combating wintry precipitation on our roadways. There is growing interest in the design and utilization of systems that automatically adjust a salt spreader's deicing material (salt) dispensation rate based on observed grip levels in real time. The project aims to develop a prototypical technology and equip it onto one or more of MassDOT's salt spreaders to calibrate a salter's material dispensation rate to observed grip levels.

#### **5. Cross-Modal Impact Assessment for Sustainable Transportation Networks (Continuing Project)**

State agencies must make large investments into the transportation system which should be environmentally friendly, equitable and cost-effective which defines the three pillars of sustainable development. Therefore, when investing in a multi-mode transportation system, the following questions are crucial for defining the sustainability of the system: 1) What is the best way to quantify complex impacts across multiple domains (i.e., social, economic, and environmental)? 2) How does an agency quantify the impact of taking different transportation modes? 3) How can policy decisions about mode choice be evaluated through an equity lens? This project has three objectives: 1) introducing normalized metrics that can be used for cross-modal comparisons; 2) quantifying impacts in social, economic, and environmental dimensions; and 3) analyzing investment decisions with respect to equity.

#### **6. Speed Management and Emergency Personnel (Continuing Project)**

Emergency Personnel are frequently cited as reason not to implement speed management roadway treatments. The objective of this research is to learn more about specific concerns, how communities have overcome them, and share back exemplary case studies from Massachusetts for our new [mass.gov/safe-speeds](https://mass.gov/safe-speeds) site. Additionally, research could include pilot and testing of treatments. The

resulting data will be used to inform standards and specifications on speed management treatments that are workable for emergency personnel while still controlling speed.

During the scoping process in early Q2, it became apparent that a synthesis of state-of-the-practice and stakeholder engagement are necessary to identify the suitable speed management countermeasures and strategies for successful field experiments. With FHWA's approval, a synthesis study has been issued under Task B MCRP, and F.6. is put on hold until the synthesis study findings are delivered.

#### **7. LIMMS Gap Analysis and Development Plan (Continuing Project)**

The Laboratory Information Materials Management System (LIMMS) was designed as a secure platform to streamline and centralize materials data collection and provide tools to analyze patterns and trends statewide. The current design of LIMMS limits the expected benefits of the system. Through this project, MassDOT will investigate alternative software that can meet or exceed MassDOT's technical and design requirements. The purpose of this project is to conduct a gap analysis that will examine the needs of LIMMS users from system design to functionality. Findings will be used to inform the selection of future LIMMS software vendors. LIMMS Vendor Analysis (task 2) is expected to be completed by FFY23. The remaining tasks are expected to be completed in FFY24 include a Gap Analysis Report, Vendor List, and Final Report.

#### **8. Smart work zone control and performance evaluation based on trajectory data (Continuing Project)**

The goal of this study is to develop computer vision technologies to extract trajectories of vehicles approaching work zones, and use the results to analyze driver behavior, identify safety hazards, and develop effective control strategies. The findings can be integrated into the existing MassDOT smart work zone systems for dynamic traffic control and can also be used to analyze and improve traffic operations at on-ramps and entrances of managed lane facilities. Work Zone experiments are continuing, and data is being reviewed. Experiment design is being refined.

#### **14. Post-Fire Damage Inspection of Concrete Structures Phase III – Field Verification Phase (Continuing Project)**

Built upon efforts of previous phases, this project addresses site conditions through in-situ heat testing of structural elements scheduled for demolition and evaluation of concrete patching materials subjected to high thermal load. This will allow for field results (including moisture content and thermal conductivity) to verify results from the laboratory tests, as well as proof of concept for using the heating set up in field testing. Testing will only be completed on components that are scheduled for demolition or removal and are expected to include both tunnel (wall or panel elements) and bridge components (deck, abutment or pier). In addition, Phase III will also evaluate the performance of

concrete patches under extreme fire temperatures and test new materials which are currently proposed as protection methods for future tunnel structures in MassDOT. A no-cost-time-extension is expected in early Q1.

### **15. Measuring Fare Payment Compliance on MBTA Buses and Light Rails (Continuing Project)**

Fare collection is a critical revenue stream for transit agencies, and evasion or underpayment reduces these needed revenues.

Most MBTA riders are required to pay fares either on a pre-trip basis or by purchasing a pass, although some riders are eligible to use the system for free. Faregates in MBTA heavy rail stations provide reliable measures of fare non-payment but it is more difficult to understand who is evading payment and how often on buses and light rail vehicles without direct manual observations. As the MBTA implements new fare and proof of payment policies, it is important to track any changes in fare-evasion over time. This project has two objectives: 1) use existing data from infrequent manual observations and from continuous AFC and APC devices to estimate rates of fare evasion on buses and light rail vehicles, and 2) develop a method to identify when and where manual spot checks of fare payment/evasion behaviors are most valuable.

### **16. Effectiveness of Two-stage Turn Queue Boxes in Massachusetts: A Comparison with Bike Boxes (Continuing Project)**

A recently completed MassDOT study investigated both motorist and bicyclist behavior at single-stage bike box locations using field data from Massachusetts, and this project will assess the effectiveness of two-stage turn queue boxes. Results will be compared with the completed study to develop a design and implementation guideline for these two treatments. Data of interest that will be collected from field studies include how bicyclists are using these treatments (e.g., turning maneuvers, use of bike lane upstream) and how drivers behave when encountering these treatments, conflicts between bicycles and cars, as well as design characteristics. Design characteristics of specific bike box and two-stage turn queue box implementations, e.g., dimensions, the existence of green pavement markings vs. plain markings, and their impact on bicyclist and driver behavior and conflicts, will also be studied to inform design guidelines. Final report to be submitted by the end of November 2023. Project is set to close out in February 2024.

### **17. Developing a Visualization, Sharing and Processing Platform for Large-Scale Highway Asset Point Cloud Data (Continuing Project)**

MassDOT initiated procurement of a Mobile LiDAR unit this year. Due to the large size and the complex format, the utilization of the data has been burdened with expensive hardware, proprietary software, extensive training, and inflexible workflow. The point cloud data is only beneficial if MassDOT has the means to extract, process, access and visualize the information. There is a great

need for a convenient platform that can maximize the utilization of the valuable point cloud data. The objectives of this study include 1) to develop a convenient data platform to enable visualization, sharing and processing of large-scale point cloud dataset; 2) to integrate the platform with the existing data sources and analysis tools in MassDOT; and 3) to customize processing pipelines using the platform for several MassDOT's critical highway applications and demonstrate the feasibility and benefits of the platform. Researchers have developed and continue refining the prototype Data Viewer.

**Accomplishments in prior year:**

- Completed the "Measuring Accessibility to Improve Public Health" project.
- Completed the "Developing Massachusetts Specific Trip Generation Rates for Land Use Projects" project.
- Completed the "Multisource Data Fusion for Real-Time and Accurate Traffic Incident Detection" project.
- Completed the "Post-Fire Damage Inspection of Concrete Structures in Tunnels Phase II" project.
- Completed the "Massachusetts Depth to Bedrock Project" project.
- Completed the "Outdoor Information Panels to Convey Real-Time Travel Information for Ridership Recovery" project.
- Managed the "Using Grip Sensors to Control a Salt Spreader Application Rate" project. 50% completed.
- Managed the "Smart work zone control and performance evaluation based on trajectory data" project. 58% completed.
- Managed the "Post-Fire Damage Inspection of Concrete Structures Phase III Field Verification Phase" project. 25% completed.
- Managed the "Effectiveness of Two-stage Turn Queue Boxes in Massachusetts: A Comparison with Bike Boxes" project. 45% completed.
- Scoped, contracted, kicked off and managed the "Energy-Focused Decision-making Framework for MBTA Operations and Planning" project. 33% Completion.
- Scoped, contracted, kicked off and managed the "Accessible Bus Stop Design in the Presence of Bike Lanes" project. 20% completed.
- Scoped, contracted, kicked off and managed the "Cross-Modal Impact Assessment for Sustainable Transportation Networks " project. 20% completed.
- Scoped, contracted, kicked off and managed the "LIMMS Gap Analysis and Development Plan" project. 30% completed.

- Scoped, contracted, kicked off and managed the "Measuring Fare Payment Compliance on MBTA Buses and Light Rails" project. 10% completed.
- Scoped, contracted, kicked off and managed the "Developing a Visualization, Sharing and Processing Platform for Large-Scale Highway Asset Point Cloud Data" project. 20% completed.
- Solicited and selected FFY24 medium-term research projects.

#### **Proposed activities for next year:**

- Identify PIs, develop amplified work plans, and establish ISAs and contracts for FFY24 new medium-term research projects.
- Complete the "Smart Work Zone Control and Performance Evaluation Based on Trajectory Data" project.
- Complete the "Using Grip Sensors to Control a Salt Spreader Application Rate" project.
- Complete the "Post-Fire Damage Inspection of Concrete Structures Phase III Field Verification Phase" project.
- Complete the "Effectiveness of Two-stage Turn Queue Boxes in Massachusetts: A Comparison with Bike Boxes" project.
- Complete the "Energy-Focused Decision-making Framework for MBTA Operations and Planning" project.
- Complete the "Accessible Bus Stop Design in the Presence of Bike Lanes" project.
- Complete the "Developing a Salt Spreader Control Program based on Grip Sensor" project.
- Complete the "Cross-Modal Impact Assessment for Sustainable Transportation Networks " project.
- Complete the "Speed Management and Emergency Personnel" project.
- Complete the "LIMMS Gap Analysis and Development Plan" project.
- Advance the "Measuring Fare Payment Compliance on MBTA Buses and Light Rails" project to 90% completed.
- Advance the "Developing a Visualization, Sharing and Processing Platform for Large-Scale Highway Asset Point Cloud Data" project to 85% completed.
- Scope, contract, and kick off all seven FFY24 new medium-term research projects.
- Solicit and identify the list of FFY25 medium-term research projects.

#### **Anticipated products:**

- Contracts/ISAs for FFY24 medium-term projects.
- Initiation of FFY24 medium-term projects.
- Interim deliverables and final reports for medium-term research projects that are scheduled to be completed in FFY24.

- Identification of FFY25 medium-term research projects.

**Estimated task completion:** 09-30-2024

*Estimated staff salaries and benefits:* **\$122,992.54**

MassDOT staff members	% Time to task
Patrick McMahon	25.0
Nicholas Zavolas	25.0
Anil Gurcan	25.0
Austin Sanders	25.0
Michael Flanary	20.0
Research Manager (TBH)	10.0

**Estimated task budget:** \$1,194,390.16



Estimated consultant costs: \$1,071,397.62

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
<b>2. Energy-Focused Decision-making Framework for MBTA Operations and Planning (Continuing Project) / 121534</b>	\$125,499.00	\$28,000.00	\$97,999.00	\$0.00	UMass Amherst	02-28-2023	09-30-2024
<b>3. Accessible Bus Stop Design in the Presence of Bike Lanes (Continuing Project) / 121272</b>	\$199,915.00	\$44,000.00	\$155,915.00	\$0.00	UMass Amherst	02-28-2023	08-31-2024
<b>4. Developing a Salt Spreader Control Program based on Grip Sensor (Continuing Project) / 117740</b>	\$125,000.00	\$88,000.00	\$37,000.00	\$0.00	UMass Amherst	04-25-2022	04-30-2024
<b>5. Cross-Modal Impact Assessment for Sustainable Transportation</b>	\$99,997.62	\$28,300.00	\$71,697.62	\$0.00	UMass Amherst	04-30-2022	09-30-2024

<b>Networks (Continuing Project) / 121271</b>							
<b>6. Speed Management and Emergency Personnel (Continuing Project) / 109600</b>	\$300,000.00	\$0.00	\$180,000.00	\$120,000.00	UMass Amherst	04-25-2023	04-25-2024
<b>7. LIMMS Gap Analysis and Development Plan (Continuing Project) / 121179</b>	\$300,000.00	\$115,000.00	\$185,000.00	\$0.00	UMass Amherst	05-31-2023	07-31-2024
<b>8. Smart work zone control and performance evaluation based on trajectory data (Continuing Project) / 117478</b>	\$150,000.00	\$128,991.00	\$21,009.00	\$0.00	UMass Lowell	04-12-2022	05-31-2024
<b>14. Post-Fire Damage Inspection of Concrete Structures Phase III – Field Verification Phase</b>	\$180,000.00	\$105,000.00	\$75,000.00	\$0.00	UMass Amherst	04-25-2022	02-28-2024

<b>(Continuing Project) / 117741</b>							
<b>15. Measuring Fare Payment Compliance on MBTA Buses and Light Rails (Continuing Project) / 121858</b>	\$150,000.00	\$32,000.00	\$113,000.00	\$5,000.00	UMass Amherst	04-28-2023	10-31-2024
<b>16. Effectiveness of Two-stage Turn Queue Boxes in Massachusetts: A Comparison with Bike Boxes (Continuing Project) / 118671</b>	\$149,778.00	\$118,000.00	\$31,778.00	\$0.00	UMass Amherst	08-19-2022	02-28-2024
<b>17. Developing a Visualization, Sharing and Processing Platform for Large-Scale Highway Asset Point Cloud Data (Continuing Project) / 121410</b>	\$174,999.00	\$50,000.00	\$102,999.00	\$22,000.00	UMass Amherst	02-15-2023	12-31-2024

## G. Long-term Research Projects

**Task Lead:** Michael Flanary

### **Task Purpose:**

To perform the studies contained within this task, MassDOT contracts directly with universities, research institutes and/or private companies. The respective anticipated duration of active investigation and report writing efforts for short-term, medium-term and long-term projects are, respectively: less than 15 months, 15-21 months, and longer than 21 months (including 3 months of final report review, approval and 508 compliance process). There may be occasion when a project actual duration doesn't align with the anticipated duration due to challenges arising during research investigation and beyond the project team's control. Under such circumstances, additional time may be granted pending FHWA's approval, and the project shall remain within the original category for fiscal tracking purpose. The Research Section conducts annual research problem statement (RPS) solicitations to collect research needs from agency staff. The submitted problem statements are then prioritized based on MassDOT Division/Shared-Service Office Senior Leaders' rankings, MassDOT overall priorities, and research funding eligibility and availability. The Research Section assists MassDOT project champions with literature searches; the drafting of scopes of work; identification and selection of principal investigators, and the administration of project agreements/contracts, deliverables, final report reviews and publication, and coordination with FHWA.

The purpose of "Task G. Long-term Research Projects" is to perform research projects that are longer than 21 months.

Subtasks:

### **1. Ultra-High Performance Concrete Reinforced with Multi-Scale Hybrid Fibers and Its Durability-Related Properties (Continuing Project)**

The study is to develop a novel UHPC reinforced with Multi-Scale Hybrid Fibers (MSHF) and nano-scale additives with enhancements in both early-age properties and long-term performance such as high early-age strength, low volume change, low permeability and extended service life in the presence of environmental threats in Massachusetts. The project will also develop a comprehensive understanding of the roles of MSHF, additives, and cement chemistry in improving durability-related properties of UHPC. The draft final report is now expected in FFY24 Q1 since a 2-month NCTE is in the process of being formally requested. Expect project to advance to full completion by 12/31/2023.

## **2. Complete Street and Urban Trees (Continuing Project)**

Focusing on soil impacts and root systems, the research will bring a much-needed arboricultural perspective to early project development, as well as design and construction, when it can most effectively anticipate, minimize, and mitigate impacts to trees, at the same time identifying strategies for both restoration and enhancement of the urban forest.

This research includes a multifaceted approach to surveying the state of the practice, including: a literature search of related professional journals; input from a cross-disciplinary panel of experts; an on-line survey of practicing professionals responsible for health of urban forest at select DOTs and cities.

These information resources will yield guidance documentation for preliminary corridor tree-health evaluation and general impact analysis for engineers, planners, and landscape architects, as well as consulting arborists. Research will also provide guidance for soil area planting requirements for new trees, as well as best management practices for soil protection during construction. The Online Survey (Task 3) of practicing professionals associated with select DOTs and cities responsible for the health of the urban forest and transportation corridor improvement projects, was completed in May. A ZOOM meeting with panel of experts, Project Champions was conducted on May 22, 2023 to discuss the survey results. Additional discussions were held with members of Transportation Group in the Department of Civil and Environmental Engineering to identify additional interest groups to share survey results. The PI continues to revise and enhance sections of MassDOT's Project Development & Design Guide.

## **3. Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete (Continuing Project)**

Cement concrete is the most critical building material used in the construction of our infrastructure.

However, hydraulic cement, the key ingredient of cement concrete, produces an immense amount of heat and carbon dioxide during the manufacturing process.

Recycled ground-glass pozzolan (RGGP) is a new type of material that has the potential to greatly reduce the amount of hydraulic cement (up to 50% reduction) needed in the mix design formulation.

Additionally, other hydraulic cement replacement materials used in today's cement concrete, such as fly ash and slag, are becoming more and more scarce, resulting in a problematic supply crunch and increases in cost.

The objectives of this research project include validation of the efficacy of RGGP and development of new mix design formulations with RGGP, which will lead to decreasing our carbon footprint, while increasing the quality and long-term durability of cement concrete used in MassDOT projects.

Literature Search is continuing. Samples are being produced and testing will start in the next Quarter (FFY24 Q1).

#### **4. Revised Load Rating Procedures for Deteriorated Prestressed Concrete Beams (Continuing Project)**

The project is to develop an approach to determine a safe working capacity realistically and reliably for existing precast, prestressed concrete bridges which exhibit deterioration to avoid unnecessary bridge closures while also keeping the public safe. This project is being carried out through a combination of computer model simulations and full-scale testing of actual deteriorated beams in the laboratory. Project scheduled for completion on 11/30/2023.

#### **5. Field Study to Determine Salt Usage Efficiency on Two Pavement Types (Continuing Project)**

Winter maintenance activities are a high priority to MassDOT in order to ensure its roadways are safe for the motoring public during winter events. MassDOT concerns that certain pavement surface types may have been over-treated during winter maintenance. As such, there is a need to collect and analyze field data to understand if the current treatment applications and frequencies are correct, deficient or excessive. Through field study, the project will quantify the minimum safe level of salt application for typical pavement surface types and compare the results to the current application rates and frequency. The study will also investigate both safety and environmental aspects of the current salt treatment rate and those of the determined efficient rate. Project will continue with data collection in winter 2023 (task 2) and data analysis in a technical memorandum in July 2024 (task 3).

#### **6. Evaluating Driver Education Modules on Safety (Continuing Project)**

This project intends to conduct a comprehensive examination of the contents of current Massachusetts driver's education modules and their delivery methods to determine which, if any, modules of the program positively influence novice driver behavior and improve roadway safety. Additionally, there are numerous new technologies affecting drivers, such as advanced driving assistance systems, that are not yet covered under any drivers' education modules. The project will yield data and an associated report detailing the effectiveness of drivers' education on improving safety and reducing drivers' citations, guidelines/standards for driver's education components, delivery methods, etc. that lead to optimal effectiveness. It will also provide guidance on the creation and implementation of new modules covering emerging technologies affecting drivers. Project technical panel will be comprised of RMV and relevant Highway Division Sections. The PIs are focused on Task 1 activities involving (1) the identification of stakeholder invitees and (2) developing the interview protocol for stakeholder interaction. Stakeholders will include 5 groups (drivers education instructors, MassDOT employees, law enforcement, academicians, and vehicle dealerships). Task 2 activities will focus the training program on one the implementation of ADAS - adaptive cruise control.

## **8. Development of Improved Inspection Techniques using LiDAR for Deteriorated Steel Beam Ends (Continuing Project)**

Through recently completed research, MassDOT has developed new improved procedures to accurately describe the remaining load carrying capacity of deteriorated steel beams, and has also explored using LiDAR scanning technology for acquiring crucial data for load rating in the lab environment. This project employs the LiDAR scanner for a field verification of the methodology. This will produce field results reflecting challenges faced by bridge inspectors in the field, a comparison with lab results from Phase II, and verification of using the 3D scanning technology for bridge inspection in reality. More specifically, the study will collect data using the LiDAR in the field, develop appropriate methods to process the data (filter noise, scale the problem, etc.) and use the output to provide important information for the estimation of the residual capacity.

LIDARs continue being tested in the lab. Researchers have continued using additional LiDars and trying to find out which ones are better for scanning deteriorated beam ends. They are investigating the Artec Leo. Researchers are using the beams that they have in the lab for testing and have acquired the first point clouds. Researchers are currently studying the new Leo Technology. Data on Beams in lab continues being loaded into the Cloud Point.

## **9. Measuring Accessibility to Improve Public Health Phase II (Continuing Project)**

Efforts have been made to quantify the access that communities across Massachusetts have to opportunities like jobs, food, healthcare, and education.

The first phase accounted for different modes but did not consider the built environment and transportation infrastructure's impact on accessibility. This research expands on current work on the measurement of accessibility to focus on the data and metrics needed to adequately account for access by bicycling, walking, microtransit, and ridesource/ridesharing services. This research has two objectives: 1) develop measures of accessibility for alternative modes of transportation that account for relevant characteristics of infrastructure, built environment, and hours and area of service, and 2) identify gaps and inequities in accessibility that can be addressed by improving transportation access. Expected to be kicked off in Q1 of FFY24.

## **10. 3D-Printed Lattice-based Structures for Next Gen Bridge Bearings (Continuing Project)**

Bridge bearings are installed between the bridge substructure and the superstructure to transfer loads and allow controlled translations to reduce stresses in the structure. Recent progress in 3D printing applications through the MassDOT research program examined promising customizable designs for typical bridge bearing and isolation bearings. This project will develop a prototype architected bearing system and manufacture and test the 3D printing bearing systems, and will involve the design of architected lattices which will serve as the reinforcement of the rubber elastomer

intended to replace the undesirable lead core in the traditional isolation bearings. The main research efforts including the manufacturing of the prototype and testing of the composite bearings for a variety of loading conditions. There is a proposed 12.8% increase (\$25,600) of the originally envisioned project amount, which can be accommodated within the SPRII Task G total amount. Manufacturing of a prototype bridge bearing and testing (task 2) and a survey of the key factors related to the newly developed bridge bearings and necessary equipment, or an on-site repair of a deteriorated bearing (task 4) will be started in October 2023 and completed by September 2024. Survey existing and emerging lattice architectures that can be applicable to deteriorated bearings (task 1) will be completed in August 2023 and task 4 will be started.

#### **11. A Method for Pavement Marking Inventory and Retroreflectivity Condition Assessment Using Mobile Lidar - Phase II (Continuing Project)**

FHWA's minimum pavement marking retroreflectivity level requirement in the forthcoming MUTCD creates a pressing need for MassDOT to implement an effective and efficient means for pavement marking inventory and retroreflectivity assessment. Phase 1 of this project successfully developed an automated methodology for identifying pavement marking, evaluating retroreflectivity condition and surface condition.

The objective of Phase 2 of this project is in two fold: 1) to continue monitoring the existing testing sections and include more sections with waterborne and preformed tape, and to investigate the effects of wet marking, recessed marking and skip sections on the retroreflectivity. 2) to investigate the feasibility of using a LiDAR-based methodology for the QA/QC processes of newly installed pavement markings. Task 1 - Literature Review is complete. The Research team is engaged in Task 2 Data Acquisition activities. A total of 17 testing roadway sections have been finalized.

#### **12. Effect of Asphalt Binder Source in Asphalt Mixture Performance (Continuing Project)**

There is a need to understand how asphalt binder source affects the asphalt mixture's overall performance between laboratory and paving settings. The research will investigate how binder source affects mixture performance by determining properties with significant variation, determining the mixture changes that significantly affect performance, analyzing the lifecycle cost based on binder properties, establishing specifications for allowable tolerances, and providing guidance on updating MassDOT pavement specifications to include new testing protocols. Binder tests are continuing.

Researchers are continuing to obtain additional Binder specimens for testing.

#### **Accomplishments in prior year:**

- Completed the "Ultra-High-Performance Concrete Reinforced with Multi-Scale Hybrid Fibers and Its Durability-Related Properties" project.



- Completed the "Revised Load Rating Procedures for Deteriorated Prestressed Concrete Beams" project.
- Completed the "Optimization of MassDOT's High Performance Thin Lift Mixtures" project.
- Completed the "Complete Streets v.2: Respecting the Roots" project.
- Completed the "Development of Improved Inspection Techniques using LiDAR for Deteriorated Steel Beam Ends" project.
- Managed the "Field Study to Determine Salt Usage Efficiency on Two Pavement Types" project to 50% completion.
- Scoped, contracted, kicked off and managed the "3D-Printed Lattice-based Structures for Next Gen Bridge Bearings" project to 10% completion.
- Scoped, contracted, kicked off and managed the "Effect of Asphalt Binder Source in Asphalt Mixture Performance" project to 30% completion.
- Scoped, contracted, kicked off and managed the "Evaluating Driver Education Modules on Safety" project to 15% completion.
- Scoped, contracted, kicked off and managed the "Method for Pavement Marking Inventory and Retroreflectivity Condition Assessment Using Mobile Lidar (Phase II)" project to 40% completion.
- Scoped, contracted, and kicked off the "Measuring Accessibility to Improve Public Health Phase II" project. 2% completion.
- Scoped, contracted, and kicked off the "Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete" project. 2% completion.
- Solicited and selected FFY24 long-term research projects.

#### **Proposed activities for next year:**

- Complete the "Field Study to Determine Salt Usage Efficiency on Two Pavement Types" project.
- Complete the "3D-Printed Lattice-based Structures for Next Gen Bridge Bearings" project.
- Complete the "Method for Pavement Marking Inventory and Retroreflectivity Condition Assessment Using Mobile Lidar (Phase II)" project.
- Complete the "Effects of Asphalt Binder Source in Asphalt Mixture Performance" project.
- Advance the "Field Study to Determine Salt Usage Efficiency on Two Pavement Types" project to 70% completion.
- Advance the "Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete" project to 50% completion.
- Advance the "Evaluating Driver Education Modules on Safety" project to 50% completion.
- Advance the "Measuring Accessibility to Improve Public Health Phase II" project to 50% completion.

- Scope, contract, and kick off all FFY24 new long-term research projects.
- Solicit and identify FFY25 long-term research projects.

**Anticipated products:**

- Contracts/ISAs for FFY24 long-term projects.
- Initiation of FFY24 long-term projects.
- Interim deliverables and final reports for long-term research projects that are scheduled to be completed during FFY24.
- Identification of FFY25 long-term projects.

**Estimated task completion:** 09-30-2024

*Estimated staff salaries and benefits:* **\$111,002.54**

MassDOT staff members	% Time to task
Patrick McMahon	25.0
Nicholas Zavolas	25.0
Anil Gurcan	25.0
Austin Sanders	25.0
Michael Flanary	20.0
Research Manager (TBH)	10.0

**Estimated task budget:** \$1,316,939.54

Estimated consultant costs: \$1,205,937.00

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
<b>1. Ultra-High Performance Concrete Reinforced with Multi-Scale Hybrid Fibers and Its Durability-Related Properties (Continuing Project) / 115287</b>	\$197,402.00	\$192,402.00	\$5,000.00	\$0.00	UMass Lowell	08-05-2021	10-30-2023
<b>2. Complete Street and Urban Trees (Continuing Project) / 117524</b>	\$89,897.00	\$62,345.00	\$27,552.00	\$0.00	UMass Amherst	04-01-2022	08-31-2024
<b>3. Recycled Ground-Glass Pozzolan (RGGP) for Use in Cement Concrete (Continuing Project / 122821</b>	\$250,000.00	\$18,638.00	\$160,000.00	\$71,362.00	UMass Lowell	08-29-2023	05-31-2025
<b>4. Revised Load Rating Procedures for Deteriorated</b>	\$224,676.00	\$221,000.00	\$3,676.00	\$0.00	UMass Amherst	04-27-2021	11-30-2023

<b>Prestressed Concrete Beams (Continuing Project) / 114071</b>							
<b>5. Field Study to Determine Salt Usage Efficiency on Two Pavement Types (Continuing Project) / 119609</b>	\$450,000.00	\$103,983.00	\$225,000.00	\$121,017.00	UMass Dartmouth	08-30-2022	09-30-2025
<b>6. Evaluating Driver Education Modules on Safety (Continuing Project) / 121727</b>	\$369,999.00	\$20,000.00	\$188,000.00	\$161,999.00	UMass Amherst	04-04-2023	09-30-2025
<b>8. Development of Improved Inspection Techniques using LiDAR for Deteriorated Steel Beam Ends (Continuing Project) / 117416</b>	\$199,998.00	\$135,000.00	\$64,998.00	\$0.00	UMass Amherst	03-21-2022	03-31-2024
<b>9. Measuring Accessibility to Improve Public Health Phase II</b>	\$200,000.00	\$7,000.00	\$103,000.00	\$90,000.00	UMass Amherst	None	None

<b>(Continuing Project) / None</b>							
<b>10. 3D-Printed Lattice-based Structures for Next Gen Bridge Bearings (Continuing Project) / 121135</b>	\$225,599.00	\$30,000.00	\$123,000.00	\$72,599.00	UMass Amherst	03-03-2023	05-31-2025
<b>11. A Method for Pavement Marking Inventory and Retroreflectivity Condition Assessment Using Mobile Lidar - Phase II (Continuing Project) / 121137</b>	\$200,000.00	\$38,000.00	\$130,000.00	\$32,000.00	UMass Amherst	01-26-2023	02-28-2025
<b>12. Effect of Asphalt Binder Source in Asphalt Mixture Performance (Continuing Project) / 121136</b>	\$400,000.00	\$51,023.00	\$175,711.00	\$173,266.00	UMass Dartmouth	02-02-2023	09-30-2025

## H. National RD&T2 Collaboration

**Task Lead:** Steve Woelfel

### **Task Purpose:**

To coordinate MassDOT's participation in national and regional transportation research activities, including the research committees, research statement submission and reviews, project panels, technical working groups, and task forces; to disseminate MassDOT's research efforts, products, program management and delivery approaches both nationally and regionally; and to distribute research results and activities of the Transportation Research Board (TRB), American Association of State Highway and Transportation Officials (AASHTO) and other state DOTs within MassDOT.

### **Accomplishments in prior year:**

- Coordinated with MassDOT Highway Divisions and Planning Office to establish participation in transportation pooled fund (TPF) projects funded through SPRII.
- Participated in and contributed to AASHTO RAC activities.
- Coordinated the TRB National Cooperative Highway Research Program (NCHRP) problem statement review process.
- Disseminated TRB research reports, technical webinars and NCHRP project panel member solicitations to appropriate MassDOT staff.
- Participated in and contributed to New England Transportation Consortium (NETC) program management and technical activities.
- Participated in and contributed to AASHTO's RAC Regional 1 activities including preparation activities for the RAC 2023 winter meeting.
- Applied for AASHTO RAC Committee High Value Research Projects Award and received Maintenance Supplemental Category Award.
- Updated MassDOT research projects in the TRB Research-In-Progress database.
- Disseminated MassDOT research reports through the TRB E-Newsletter.

### **Proposed activities for next year:**

- Coordinate within MassDOT to establish participation in pooled fund programs, and support AASHTO RAC activities, NCHRP research statement reviews, NCHRP technical panel participation, and TRB representative's visit.
- Participate in the remaining NETC project activities in FFY24.
- Participate in other State DOT's Research Peer Exchanges when appropriate.
- Plan for the next MassDOT Research Peer Exchange.

**Anticipated products:**

- Distribution of research products and information from TRB, TPF and other state DOTs.
- Communication of MassDOT research reports through TRB E-Newsletter.
- Participation in AASHTO RAC activities.
- Next Research Peer Exchange scheduled, agenda drafted, and invitations sent.
- Identification of MassDOT's position on problem statements for the annual NCHRP project cycle.
- Coordination of MassDOT subject matter experts' participation in NETC projects.

**Estimated task completion:** 09-30-2024*Estimated staff salaries and benefits:* **\$68,021.15**

MassDOT staff members	% Time to task
Patrick McMahon	20.0
Michael Flanary	10.0
Nicholas Zavolas	10.0
Anil Gurcan	10.0
Austin Sanders	10.0
Research Manager (TBH)	10.0

**Estimated task budget:** **\$68,021.15***Other costs:* \$1,245,154

## Transportation Pooled Fund Projects

Below is a list of Transportation Pooled Fund projects with a total cost of \$1,245,154 (eligible for 100% federal SPRII funds and not included in the FFY24 SPR financial table but will be included in the FFY24 STIP as its own line item).

They are noted here for informational purposes:

5(422)\* National Cooperative Highway Research Program, \$826,802

5(437) Tech Transfer Concrete Consortium, \$12,000

5(447) Traffic Control Device (TCD) Consortium, \$10,000

5(455) National Accessibility Evaluation Phase II, \$38,000

5(464) H&H software updates, \$10,000

5(479) Clear Roads Phase III, \$25,000

5(481) In-Service Performance Evaluation (ISPE) of Roadside Safety Features, \$30,000

5(482) Development and Evaluation of Roadside Safety Systems for Motorcyclists, \$40,000

5(501) Roadside Safety Research for MASH Implementation Phase III, \$65,000

5(511) TRB Core Support Services \$157,352

5(516) Highway Safety Manual 2nd Edition (HSM2) Implementation Phase III \$16,000

S 1591\*\* 2nd International Roadside Safety Conference and Peer Exchange Conference, \$5,000

Contingency for FFY 24: \$10,000 (for the variation of NCHRP amount)

\* Exact amount will be determined by FHWA headquarters based on 5.5% of SPR total for Massachusetts

\*\* TPF project number yet to be assigned.



## I. Construction Management Certificate Program (Delivered by MassDOT HR Training)

**Task Lead:** Penny Nickle

### **Task Purpose:**

To support MassDOT HR Training Program activities that provide oversight and administration of the MassDOT/Wentworth Construction Management Certificate Program (CMCP) for employees of the MassDOT Highway Division.

### Construction Management Certificate Program

Implement year three of the 3-year partnership agreement with the Wentworth Institute of Technology (WIT).

Deliver the Construction Management Certification Program to 30 participants representing all Highway districts. The annual expense is \$60,000. This annual expense covers the delivery of the previously approved 7-week curriculum (the module contents had been jointly developed by WIT and MassDOT in FFY18 and approved by FHWA in FFY19).

It is anticipated that about thirty (30) MassDOT Highway construction staff will attend the 7-week training program each year. The third annual training to be delivered under this contract will be January - March 2023:

- January 23, 2024
- January 25, 2024
- February 6, 2024
- February 8, 2024
- February 13, 2024
- February 15, 2024
- February 27, 2024
- February 29, 2024
- March 5, 2024
- March 7, 2024
- March 12, 2024
- March 14, 2024
- March 19, 2024
- March 21, 2024

Subtasks:

### **Construction Management Certificate Program**

Continue implementing the 3-year partnership agreement with the Wentworth Institute of Technology (WIT).

Deliver the Construction Management Certification Program to 30 participants representing all Highway districts. The annual expense is set at \$60,000, which covers the delivery of the 7-week curriculum (the module contents had been jointly developed by WIT and MassDOT in FFY18 and approved by FHWA in FFY19).

It is anticipated that about thirty (30) MassDOT Highway construction staff will attend the 7-week training program each year. The third annual training to be delivered under this contract will be January - March 2024. No training was conducted in FFY21 due to COVID restrictions.

#### **Accomplishments in prior year:**

- Worked with Wentworth Institute to Management Certificate Program in January – March 2023.

#### **Proposed activities for next year:**

- Implement year three of the 3-year partnership agreement with the Wentworth Institute of Technology.
- Deliver the Construction Management Certification Program to 30 participants representing all Highway districts. The annual expense is \$60,000 to pay for the delivery of the previously approved 7-week curriculum.

#### **Anticipated products:**

- Administration of the Mass DOT/Wentworth Construction Management Certificate Program

**Estimated task completion:** 09-30-2024

**Estimated task budget:** \$60,000.00

Estimated consultant costs: \$60,000.00

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
Construction Management Certificate Program / 113551	\$180,000.00	\$60,000.00	\$60,000.00	\$60,000.00	Wentworth	01-15-2021	None

Consultant notes: \$180,000 for 3 years (\$60,000 per year).

## J. MassDOT Moving Together and Innovation Conferences

**Task Lead:** Steve Woelfel

### **Task Purpose:**

MassDOT convenes two transportation technology transfer conferences each year: a one-day Moving Together Conference in the fall and a two-day Transportation Innovation Conference in the spring.

Through the comprehensive MassDOT-UMass Amherst Interdepartmental Service Agreement (ISA #109600), UMTC provides services to MassDOT including conference program planning, coordinating with speakers and moderators, managing event registration and exhibitors, contracting with venue and event support services, managing conference logistics, and delivering the conferences.

Subtasks:

### **MassDOT Conferences**

Conference supporting efforts and expenses were previously embedded in other UMTC ISA components (mostly LTAP); they are separated from those components and included in SPRII Work Program Task J for FY23-FY25 through the ISA Amendment.

### **Accomplishments in prior year:**

- Delivered the 2022 Moving Together conference.
- Delivered the 2023 Innovation Conference.

### **Proposed activities for next year:**

- Coordinate in-person and partial virtual delivery of conference content and host the annual conference.
- Explore equitable delivery options for future conferences.
- Support the conference organizing committee by coordinating logistics both for the UMTC conference planning committee as well as those involved on the MassDOT event planning team. UMTC will also support conference planning logistics between any vendors or consultants providing services for the conference.
- Manage initiatives to secure sponsors, vendors, and exhibitors.
- Manage conference content including presenters, moderators and facilitators, abstracts, agenda items, schedule, and accompanying projects including video creation and editing.
- Provide day-of support relating to registration, troubleshooting any issues or concerns, managing flow of the conference, providing support for featured speakers and session speakers.

- Manage temporary conference student workers, including advertising, interviewing, training, scheduling and day-of coordination.
- Work with MassDOT to provide talking points and press release content as needed.
- Prepare marketing materials prior to and for day-of conference activities including email marketing campaigns, website information, virtual platform needs (if virtual), agenda, social media messaging, conference app preparation (if using an app), posters, day-of signage, evaluation collection materials, final reports, etc.
- Manage and secure all vendor contracts, billing, invoices, expense reports, payroll and reimbursements

**Anticipated products:**

Delivery of 2023 Moving Together Conference.

Delivery of 2024 Innovation Conference.

**Estimated task completion:** 09-30-2024

*Estimated staff salaries and benefits:* **\$22,126.40**

MassDOT staff members	% Time to task
<b>Research Manager (TBH)</b>	15.0
<b>Michael Flanary</b>	None

**Estimated task budget:** \$872,126.40

Estimated consultant costs: \$850,000.00

Subtask / contract #	Total cost:	Pre-FFY 2024:	FFY 2024:	Post-FFY 2024:	Consultant/Contractor Name:	Consultant NTP:	Contract End Date:
MassDOT Conferences / 109600	\$2,553,823.00	\$858,260.22	\$850,000.00	\$845,562.78	UMass Amherst	10-01-2022	09-30-2025

Consultant notes: This Task is to be separated from other UMTC services through the ISA Amendment for FFY23-25. Thus, the duration is 36 months.

## K. Activities with non-Federal-Match Waivers -- AASHTO TSP

**Task Lead:** Maria Ramirez

**Task Purpose:**

This task will allow MassDOT subscribes to a list of AASHTO Technical Services Programs which are approved for SPRII non-federal match waivers. 100% federal funds will be used to pay for these services.

**Accomplishments in prior year:**

Coordinated with Highway on programs to subscribe for FFY24.

**Proposed activities for next year:**

Pay for the subscribed services.

**Anticipated products:**

AASHTO TSP invoices are paid.

**Estimated task completion:** 09-30-2024

**Estimated task budget:** \$205,000.00

*Estimated other costs:* \$205,000.00

In FFY24, MassDOT intends to participate in the following AASHTO TSP programs with a total cost of \$205,000; and they are eligible for 100% federal share for SPR funds per FHWA guidance:

- AASHTO Design Guidelines - (Formerly Design Publications Maintenance Technical Service Program, DPM) \$15,000
- AASHTO Innovation Management - (Formerly AASHTO Innovative Initiative, A.I.I.) \$6,000
- AASHTO Materials Guidelines - (Formerly Development of AASHTO Materials Standards, DAMS) \$10,000
- AASHTO Environmental Management - (Formerly Environmental Technical Assistance Program, ETAP) \$10,000
- AASHTO Equipment Management - (Formerly Equipment Management Technical Service Program, EMTSP) \$5,000
- AASHTO Safety Management - (Formerly Highway Safety Policy and Management Technical Service Program, SAFETY) \$10,000

- AASHTO Structures Guidelines, \$15,000 - (Formerly LRFD Bridges and Structures Specifications Maintenance, LRFDSM) \$15,000
- AASHTO Safety Hardware Management, \$10,000 - (Formerly Manual for Assessing Safety Hardware Technical Support, MASH) \$10,000
- AASHTO Performance Management - (Formerly Transportation Performance Management Technical Service Program, TPM) \$15,000
- AASHTO Preservation Management - (Formerly Transportation System Preservation Technical Service Program, TSP2) \$20,000
- AASHTO Product Evaluation and Audit Solutions - (Formerly National Transportation Product Evaluation Program, NTPEP) \$25,000
- AASHTO Resilient and Sustainability Management - (Formerly Resilient and Sustainable Transportation Systems Technical Assistance Program, RSTS) \$10,000
- AASHTO Technical Training Solutions - (Formerly Transportation Curriculum Coordination Council, TC3) \$20,000
- AASHTO Winter Weather Management - (Formerly Snow and Ice Cooperative Program, SICOP) \$4,000
- National Operations Center of Excellence Technical Service Program (NOCoe) \$15,000
- AASHTO Operations Technical Services Program (Ops TSP) \$15,000



# SPR II Financial Table

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## Totals

Task	Staff cost	Consultant cost	Other cost	Total task cost
<b>SPR II Totals</b>	\$609,508.10	\$6,962,701.62	\$605,000.00	\$8,177,209.72

The SPR will be monitored throughout the year to determine if an amendment to the STIP is necessary to ensure adequate funding. The SPR II is 27% of the overall program, meeting the 25% minimum threshold.